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## CONNECTION ESTABLISHMENT IN A WIRELESS TELECOMMUNICATIONS NETWORK

The invention relates to wireless telecommunication systems.

5 In mobile networks, radio interfaces have conventionally been narrowband. Mobile network transmission systems have conventionally been implemented with circuit-switched connections using a star or tree network configuration. An example of prior art mobile systems are the pan-European digital mobile communication system GSM. The signalling interface is based on  
10 an ANSI/CCITT signalling system number 7 (SS7) comprising several layers: an SCCP, an MTP and a physical layer. When a digital PCM link is used between the BSC and the mobile switching centre 10, the signalling of the physical layer is transferred in one or more time slots of 56 or 64 kbit/s. The following higher layers at interface A are an MTP (message transfer part) and an  
15 SCCP (signalling connection and control part). The MTP and the SCCP are used to support layer 3 signalling messages between the mobile switching centre and the base station system BSS. One function of SCCP, a BSSMAP (BSS management application sub-part) supports procedures between the mobile switching centre and the BSS relating to the mobile station (handover control 14 ms) or a cell within the BSS or the entire BSS. In other words, the  
20 BSSMAP (RSMAP) supports all the procedures between the mobile switching centre and the BSS requiring interpretation and handling of information associated with individual calls and resource management, i.e. radio network specific or mobile specific information. In the terminology used in this description, BSSMAP may be called a radio network layer and the underlying PCM transmission system a transport layer. In GSM, the transport layer reference, i.e.  
25 PCM timeslot number information is carried in the BSSMAP signalling.

At present third generation mobile systems, such as Universal Mobile Communication System (UMTS) and Future Public Land Mobile Telecommunication System (FPLMTS) later renamed as IMT-2000 (International Mobile Telecommunication 2000), are being developed. The UMTS is being  
30 standardized in ETSI (European Telecommunication Standards Institute) whereas ITU (International Telecommunication Union) is defining the IMT-2000 system. These future systems are basically very alike.

35 Fig. 1 shows a simplified UMTS architecture with the external reference points and interfaces to the UMTS Terrestrial Radio Access Network, UT-

RAN. The UTRAN consists of a set of Radio Network Subsystems RNS connected to the Core Network CN through the  $I_u$ . These Radio Network Subsystems can be interconnected together through the interconnection point (reference point)  $I_{ur}$ . The interfaces  $I_u(s)$  and  $I_{ur}$  are logical interfaces.  $I_{ur}$  can

5 be conveyed over physical direct connection between RNSs or via any suitable transport network. Each RNS is responsible for the resources of its set of cells. For each connection between a User Equipment UE and the UTRAN, one RNS is the Serving RNS. A RNS consists of a Radio Network Controller RNC and one or more abstract entities currently called Node B. The RNC is

10 responsible for the handover decisions that require signalling to the UE. Nodes B are connected to the RNC through the  $I_{ub}$  interface. The functions and internal structure of Node Bs are currently undefined. The core network CN is a conventional or future telecommunication network modified to efficiently utilize the UTRAN in a wireless communication. Telecommunication networks that

15 are thought to be suitable core networks are second generation mobile systems, such as GSM, ISDN (Integrated Services Digital Network), B-ISDN (Broadband ISDN), PDN (Packet Data Network), ATM etc.

The UTRAN forms an overlay layer for the transmission network. The basic idea is that UTRAN is a transmission independent system including

20 3 different system functions: user plane, radio network control plane (radio network layer) and access link control plane (transport plane). User plane transmits circuit and packet switched data, radio network control plane provides the means to carry mobile specific signalling and transport network control establishes the user channels over the UTRAN interfaces, eq.  $I_u$ ,  $I_{ur}$  and  $I_{ub}$ .

25 The radio network control plane and user plane use the services of the transport network control plane. The transport network control plane hides the underlying transport network from the UTRAN control plane. The transport network is visible to the radio network control plane only via the primitive interface through which it can request the transport services for itself and for the UT-

30 RAN user plane. The transport network control plane provides the requested transport Service Access Points (SAP) for the UTRAN user and control planes.

The invisibility of the transport network to the UTRAN radio network layer makes the UTRAN independent of the underlying transport network and it enables the use of different transport network technologies for the UTRAN.

35 This independence is seen beneficial from the UTRAN specification and development work point of view as it is no longer tied to any specific transport

technology. Furthermore, it makes the UTRAN more adaptive to the future developments of the transport technologies.

A potential candidate for transport technique in the UMTS is ATM (Asynchronous Transfer Mode). The ATM transmission technique is a switching and multiplexing solution particularly relating to a data link layer (i.e. OSI Layer 2, hereinafter referred to as an ATM layer), enabling the implementation of a connection-oriented packet network in the B-ISDN networks (Broadband Integrated Services Digital Network). In ATM data transmission the end user's data traffic is carried from a source to a destination through virtual connections. Data is transferred over switches of the network in standard-size packets called ATM cells. An ATM cell comprises a header, the main object of which is to identify a connection number for a sequence of cells forming a virtual channel for a particular call. A physical layer (i.e. OSI Layer 1) may comprise several virtual paths multiplexed in the ATM layer. The virtual paths are identified by a Virtual Path Identifier (VPI). Each virtual path may comprise a number of virtual channels identified by a Virtual Channel Identifier (VCI). The ATM cell comprises indirectly information on the receiver's address, each cell thus being an independent data transmission unit. Above the ATM layer there are the procedures of ATM Adaptation Layer (AAL) which adapt the ATM layer to the higher layers. The ATM is a connection-oriented traffic technique, but since there is no connection before it is established, a connection establishment request has to be routed from a source through the ATM network to a destination approximately in the same way as packets are routed in packet-switched networks. After the connection has been established the packets travel along the same virtual path during the connection.

In other words, a separate transport layer signalling is required for connection establishment when the transport layer is based on ATM, for example. Such established connection is called a signalled connection herein. In some cases both signalled and permanent connections (permanent virtual connection in ATM, or a TDM time slot, for example) may be used.

Other potential transport techniques are Frame Relay and Internet protocol (IP).

An object of the present invention is to allow independence of the radio network layer, such as UTRAN, from the underlying transport layer, such as ATM, while enabling coordination of the separate signalling procedures through a generic interface between these layers.

An aspect of the invention is a connection establishment method in a wireless telecommunications system comprising a radio network layer for carrying a radio network specific signalling and a transport layer for establishing user connections over a transmission system between network nodes in the telecommunications system, said method comprising the steps of requesting, by the radio network layer, the transport layer to establish a user connection between two nodes; carrying out a transport layer signalling procedure for establishing a transport layer connection; and carrying out a network layer signalling procedure for establishing a radio network layer connection establishment. The method further comprises the steps of providing a binding information for a user connection requested by the radio network layer; utilizing the binding information in said transport layer signalling procedure; utilizing the binding information in said radio network layer signalling procedure; and utilizing at the nodes the binding information to associate the transport layer signalling procedures and connections with the respective network layer signalling procedures and connections.

A further aspect of the invention is a wireless telecommunications system comprising a radio network layer for carrying a radio network specific signalling and a transport layer for establishing user connections over a transmission system between network nodes in the telecommunications system, the radio network layer signalling procedures being substantially separated from the transport layer signalling procedures. One of the two nodes is arranged to provide a binding information for a user connection requested by the radio network layer, and both the radio network layer and the transport layer are arranged to use the binding information in the signalling associated with the connection establishment in order to enable the network nodes at the ends of the user connection to associate the transport layer signalling and connections with the respective network layer signalling and connections.

In accordance with the invention, the radio network layer signalling procedures and connections are associated with the underlying transport layer signalling procedures and connections by using a binding information. The binding information associates a particular transport layer instance with its corresponding radio network layer instance. The binding information is provided at a system node at one end of the connection leg, exchanged between the network and transport layers in addition to other necessary parameters through a primitive interface, and used to "identify" the radio network layer and

information value is retrieved from the reference table and transferred to the radio network layer. This approach can be very useful for example in handover cases as response time for the transport connection establishment is very short. The nodes may be arranged to use the permanent connections based on various criteria: always when available, when preferable according a pre-determined criterium, when no signalled connections are available, or in handover.

In the following the invention will be described in greater detail by means of the preferred embodiments with reference to the accompanying drawings, in which

Figure 1 shows a simplified UMTS architecture,

Figure 2 illustrates the UTRAN reference model in case of the transport network that is based on the ATM,

Figure 3 illustrates an example of internal functions in the MSC (Mobile Services Switching Center) node,

Figure 4 shows one example of the binding ID structure,

Figures 5, 6, 7 and 8 illustrate the various signalling procedures according to the invention.

The preferred embodiments of the invention are in the following described as implemented in the UMTS system when the transport network is an ATM network. However, the aim is not to restrict the invention to these embodiments. The invention is applicable to be used in any wireless telecommunication system requiring independence of the radio network (mobile specific signalling) from the underlying transport network type.

An architecture of a UMTS access network was described above with reference to Fig. 1. Fig. 2 illustrates the UTRAN reference model in case of the transport network that is based on the ATM. In the terminology used herein the radio network control plane is the radio network layer, and the Transport Network Control (TNC) plane and the transport network provide the transport layer.

In the Transport Network Control Plane is designed for the ATM based transport network. Both the standardized ATM Connection Control signalling (PNNI, UNI, BISUP) and the AAL2 signalling protocols (ATM Adaptation Layer, type 2) are available for the use by the Transport Control application in order to provide the requested transport services. It is emphasized that the complexity and the capabilities of the Transport Network Control Plane

may vary depending on the capabilities of the underlying transport network and on the required services of any particular transport network. For example the ATM signalling may not be necessary if all communication is based on the use of Permanent Virtual Connections and/or if only AAL2 connections are controlled via signalling.

In the radio network control plane the radio network signalling over the interface  $I_{ur}$  consists of the Radio Access Network Application Part (RANAP). The RANAP consists of mechanisms to handle all procedures between the CN and the UTRAN. It is also capable of conveying messages transparently between the CN and the UE without interpretation or processing by the UTRAN. The corresponding signalling information across the  $I_{ur}$  interface is called Radio Network Subsystem Application Part (RNSAP). The present invention is applicable to all interfaces in the UTRAN.

The Transport Network Control Plane provides the capabilities and mechanisms that are needed in order to efficiently use any specific transport network for the communication needs of the UTRAN control and user planes. These capabilities may include e.g. the Traffic Management (Connection Admission Control, User Parameter Control, etc.) and Connection Control functions. The interaction of the Transport Network Control Plane with the underlying transport network is provided by the transport network specific signalling protocols. UTRAN specific procedures have access to the Transport Control Plane through the primitive interface. The primitive interface exists between the Transport Control application and the corresponding UTRAN control application (the UTRAN control application resides on both sides of the system interface, including the  $I_{ur}$ ). The Transport Control is the application that coordinates all the functions of the Transport Network Control Plane.

Transport services are requested from the Transport Network Control Plane by the UTRAN control. The Transport Control application converts the parameters to the formats that are suitable for the underlying transport network. The conversion may be needed e.g., between the UTRAN addressing and the addressing format that is supported by the transport network. Also the parameters that characterize the requested transport service (e.g., the UTRAN bearer parameters) may need to be adapted to the transport network specific parameters. The description of the primitives and the parameters that are passed through this interface are not relevant to the present invention and will not be described herein.

The binding information according to the present invention is exchanged between the two planes in addition to other necessary parameters. Binding information associates a particular Transport Network Control Plane instance to its corresponding radio network control plane instance. In the following the binding information is called a binding ID.

Fig. 3 illustrates an example of internal functions in the MSC (Mobile Services Switching Center) node and interactions which may be made in the connection setup. In a node signalling over the  $I_{ur}$  interface the basic function and primitive interfaces may be the same but RANAP is replaced by RNSAP. In the MSC node the Transport Control has, in addition to the interface to the RANAP, also several other internal interfaces. The whole connection establishment procedure starts with Call Control negotiation between MSC and MS call control entities. By using the RANAP services the radio resources are checked and when agreed, then the RANAP will request access links from Transport Network Control. That request includes generic bearer parameters and they are not tied to any certain transmission alternative. Basically radio and access link resources could be checked and reserved simultaneously to get the shortest delay. Depending on the connection and traffic management parameters in the RANAP request, the TNC will first decide the access link type. After that the Transport Control will utilize node internal control services to find out if that request can be fulfilled with the chosen access link type. That includes the Connection Control and Connection Admission Control blocks shown in Fig. 3. Routing towards the destination has to be formed also. If the RANAP request is valid, the TNC decides how this link will be established. Alternatives may be to use signalled or permanent or both link types together. After the transport link is established, the TNC will response with an (internal) acknowledgement to the RANAP and give also the binding ID to be transmitted over RANAP connection for the other node. With the binding information the other node can connect the TNC link to the RANAP connection.

The format of the binding ID is preferably such that both the radio network control plane protocol and the relevant transport Layer signalling protocol (Q.2931, Q.933, Q.AAL2, etc) can transparently convey it in their information element, typically in a user-to-user information element. For example, currently in AAL2 signalling only 32 bits are allocated for the user generated information field.

The binding ID is preferably unique at least between the neighbor-



ing nodes. For example, individuality of the binding ID can be ensured by means of a node identifier, Node ID. This is a unique identifier for each node in the UMTS system. The numbering system can be operator specific and it may be based for example on signalling point codes, ATM or AAL2 End System Addresses.

Besides the unique part the binding ID may include a consecutive number which is allocated and managed by a Resource Manager in each node. Some of these numbers can be permanently allocated for some special purpose but this is totally implementation specific issue. Fig. 4 shows one example of the binding ID structure. The total length is 32 bits where both the Node ID and consecutive ID have a number space of 16 bits allowing 65 535 different binding IDs for each connection leg between two nodes.

In the following, four different scenarios for binding of radio network layer and transport layer signalling in accordance with the invention will be described with reference to Figs. 5 to 8. The specific messages shown are only intended to illustrate the invention but similar type of messages can be found in the network and transport signalling procedures.

Fig. 5 describes the case where the originating side node A allocates the transport resource. The binding ID is requested from the node A Resource Manager and that value is inserted into Bearer\_Request messages which are sent to the node B. Depending on the interface requirements there can be a Layer 3 Proceeding message sent back from the node B. This message can be useful if node B wants to change the transport features or to give some transport addressing information to the node B. If the Layer 3 Proceeding message is not used, a transport Setup which contains same binding ID can be sent immediately after the Bearer Request message. If the Proceeding message is specified for the interface, the transport Setup message is not sent before the arrival of the Proceeding message as the latter may contain some information necessary for the transport selection procedure. This kind of transport negotiation procedure has been planned for I<sub>u</sub> Interface, for example. Even in case we have to change the transport resources, the binding ID can still be the same. Only the internal reference of the binding ID has to be updated for the new resource. Basically the new resource has to be lower than the originally allocated resource. This means that the node B may only lower the transport requirements from the one the node A is offering. It should be noted that the radio network layer and transport layer signalling

Bearer\_Request message, allocate the requested transport resource and return the Binding ID in the radio network layer Bearer\_Request\_Proceeding message. However, the node B does not send a transport layer Setup message. Instead, the node A sends the transport layer Setup message with the  
5 same binding ID in response to the radio network layer Bearer\_Request\_Proceeding message. The node B acknowledges with the transport layer Connect message. Finally, the radio network layer Bearer\_Request\_Complete message is sent from node B to the node A. This procedure can be useful if parallel processing of radio network layer and  
10 transport messages is not possible, or appropriate message synchronizing of radio network layer and transport messages is seen important. Also the benefits of allocating the binding ID at the terminating node B are obtained.

If the node A or node B allocates permanent transport resources, procedures may be exactly the same as described above, except that the  
15 transport layer Setup-Connect sequence would be left out. Binding ID would tell both ends the indirect reference to the actual physical transport resource.

The binding ID parameter may be conditional in all relevant radio network layer messages in order to allow all the scenarios described above. In each interface in the system one or more of the previous procedures may be  
20 applied, and the selected procedure will define in which network layer messages the binding ID Information element is needed.

The application has above been described by means of the preferred embodiments to illustrate the principles of the invention. Regarding the details the invention may vary within the scope and spirit of the accompanying  
25 claims.

# CLAIMS

1. A connection establishment method in a wireless telecommunications system comprising a radio network layer for carrying a radio network specific signalling and a transport layer for establishing user connections over a transmission system between network nodes in the telecommunications system, said method comprising the steps of
  - requesting, by the radio network layer, the transport layer to establish a user connection between two nodes,
  - carrying out a transport layer signalling procedure for establishing a transport layer connection, and
  - carrying out a network layer signalling procedure for establishing a radio network layer connection establishment,  
**characterized** by the steps of  
providing a binding information for a user connection requested by the radio network layer,  
utilizing the binding information in said transport layer signalling procedure,  
utilizing the binding information in said radio network layer signalling procedure,  
utilizing at the nodes the binding information to associate the transport layer signalling procedures and connections with the respective network layer signalling procedures and connections.
2. The method as claimed in claim 1, **characterized** by a step of
  - providing the binding information by the transport layer, informing the binding information to the radio network layer.
3. The method as claimed in claim 1 or 2, **characterized** by a step of
  - the transport layer dynamically allocates the binding information to each connection to be established by signalling.
4. The method according to claim 1, 2 or 3, **characterized** by the steps of
  - ending the radio network layer signalling procedure by a request complete message only after the transport layer signalling procedure is completed and radio resources and transport resources are established.
5. The method according to claim 1, 2, 3 or 4, **character-**

ized by the steps of

allocating the binding information only in one of the two nodes, and  
 sending the allocated binding information to the other one of the  
 two nodes in at least one radio network layer message and/or transport layer  
 5 message.

6. The method according to claim 5, **characterized** by a  
 step of

allocating the binding information in the terminating one of the two  
 nodes.

10 7. The method according to any one of claims 1-6, **characterized** in that the allocated binding information is unique at least in the  
 two nodes associated.

8. The method according to claims 7, **characterized** in that  
 the binding information includes a node identity.

15 9. The method according to any one of claims 1-8, **characterized** by the steps of

checking, at one of the two nodes, whether there is a pool of per-  
 manent transport layer connections between the two nodes,

allocating the requested user connection one permanent connection  
 20 from said pool instead of establishing a signalled connection by said transport  
 layer signalling procedure,

informing the binding information associated with the allocated per-  
 manent connection to the radio network layer,

25 receiving, at the other one of the two nodes, said binding informa-  
 tion from the radio network layer, said binding information being carried from  
 said one of the nodes to said other one of the nodes in said radio network level  
 signalling,

allocating, at said other one of the two nodes, for the requested  
 user connection the permanent connection associated with said binding infor-  
 30 mation,

utilizing at the nodes the binding information to associate the per-  
 manent transport layer connections with the respective network layer signalling  
 procedures and connections.

35 10. A wireless telecommunications system comprising a radio net-  
 work layer for carrying a radio network specific signalling and a transport layer  
 for establishing user connections over a transmission system between network

nodes (A, B) in the telecommunications system, the radio network layer signalling procedures being substantially separated from the transport layer signalling procedures, **characterized** in that one of the two nodes (A, B) is arranged to provide a binding information for a user connection requested  
5 by the radio network layer, and that both the radio network layer and the transport layer are arranged to use the binding information in the signalling associated with the connection establishment in order to enable the network nodes (A, B) at the ends of the user connection to associate the transport layer signalling and connections with the respective network layer signalling  
10 and connections.

11. The system as claimed in claim 10, **characterized** in that said one node (A, B) is arranged to dynamically allocate the binding information for each user connection.

12. The system as claimed in claim 10 or 11, **characterized**  
15 in that said one node (A, B) is arranged to send the allocated binding information to the other one of the two nodes (A, B) in at least one radio network layer message and/or transport layer message.

13. The system as claimed in claim 12, **characterized** in that said one node is the terminating one of the two nodes (A, B).

20 14. The system as claimed in claim 10, 11 or 12, **characterized** by comprising permanent type of transport layer connections between some of the network nodes (A, B), each permanent connection being fixedly associated with a preallocated binding information, each node (A, B) is arranged to store reference information tying the each preallocated binding information to the respective permanent connection, and that the nodes are arranged to use the permanent connections based on one or more of the following criteria: always when available, when preferable according a predetermined criterium or when no signalled connections are available.

15. The system as claimed in any one of claims 10-14, **characterized**  
30 **terized** in that the transport layer is based on the ATM (Asynchronous Transfer Mode), IP (Internet Protocol), Frame Relay, or TDM (Time Division Multiplexing).

16. The system as claimed in any one of claims 10-15, **characterized**  
35 **terized** in that the binding information is unique at least between two neighbouring nodes (A, B).

(57) ABSTRACT

A wireless telecommunication systems comprises a radio network layer which provides the means to carry mobile specific signalling, and a transport layer which establishes the user channels between system nodes over a transport network. The transport network is visible to the radio network layer only via the primitive interface through which it can request the transport services. The invisibility of the transport network to the radio network layer makes the radio network layer independent of the underlying transport network and enables the use of different transport network technologies. The radio network layer signalling procedures and connections are mapped with the underlying transport layer signalling procedures and connections by using a binding information. The binding information is provided at a system node (A) at one end of the connection leg, exchanged between the network and transport layers in addition to other necessary parameters through a primitive interface, and used to "identify" the radio network layer and the transport layer connection setup signalling carried out between the nodes.

(Figure 5)

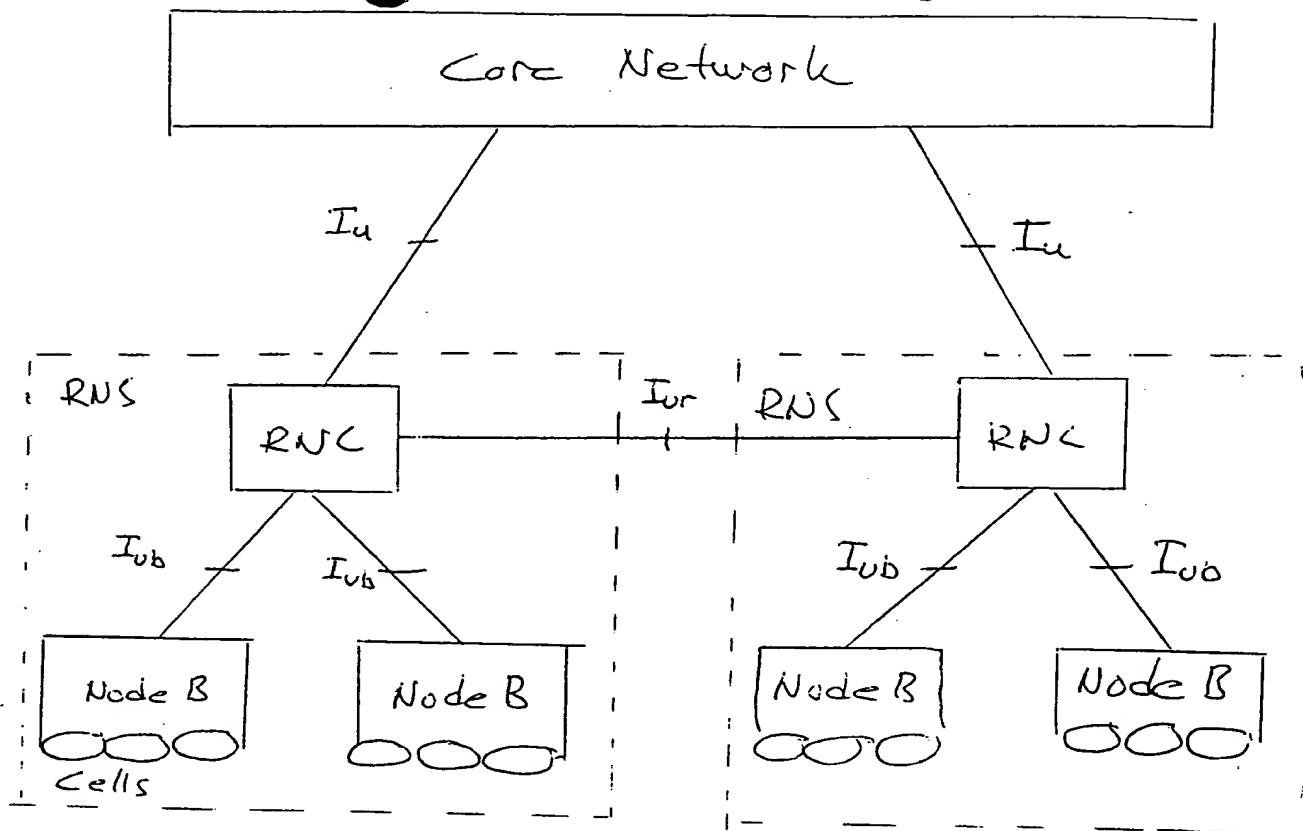


Fig. 1.

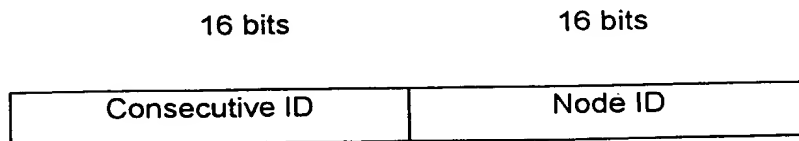


Fig. 4.

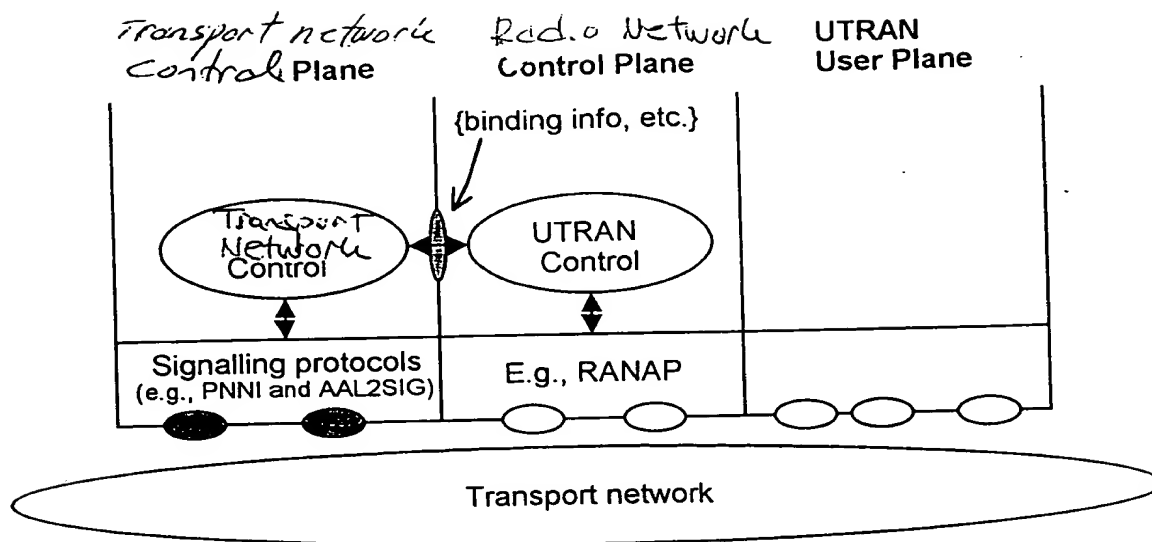


Fig. 2

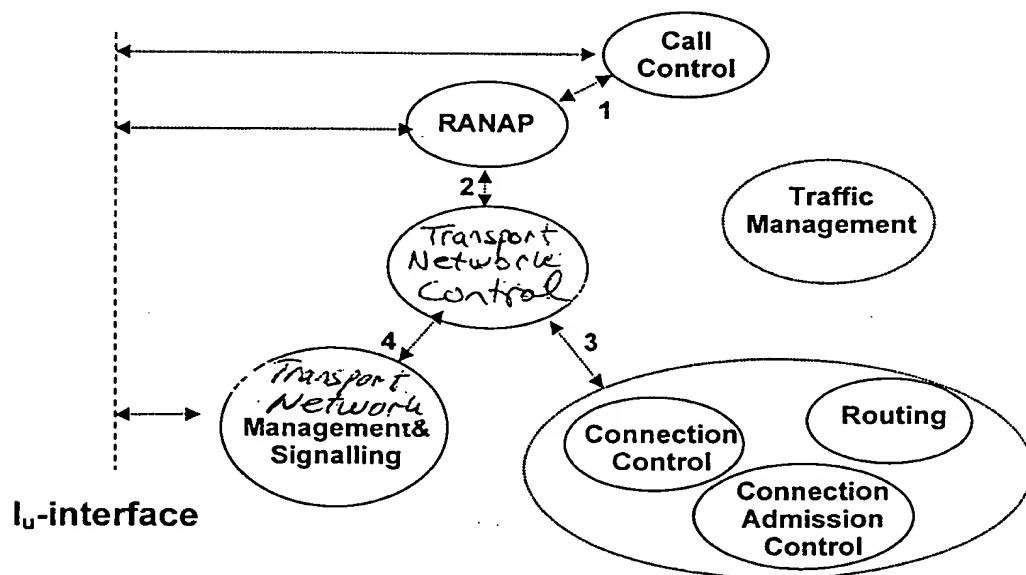


Fig. 3



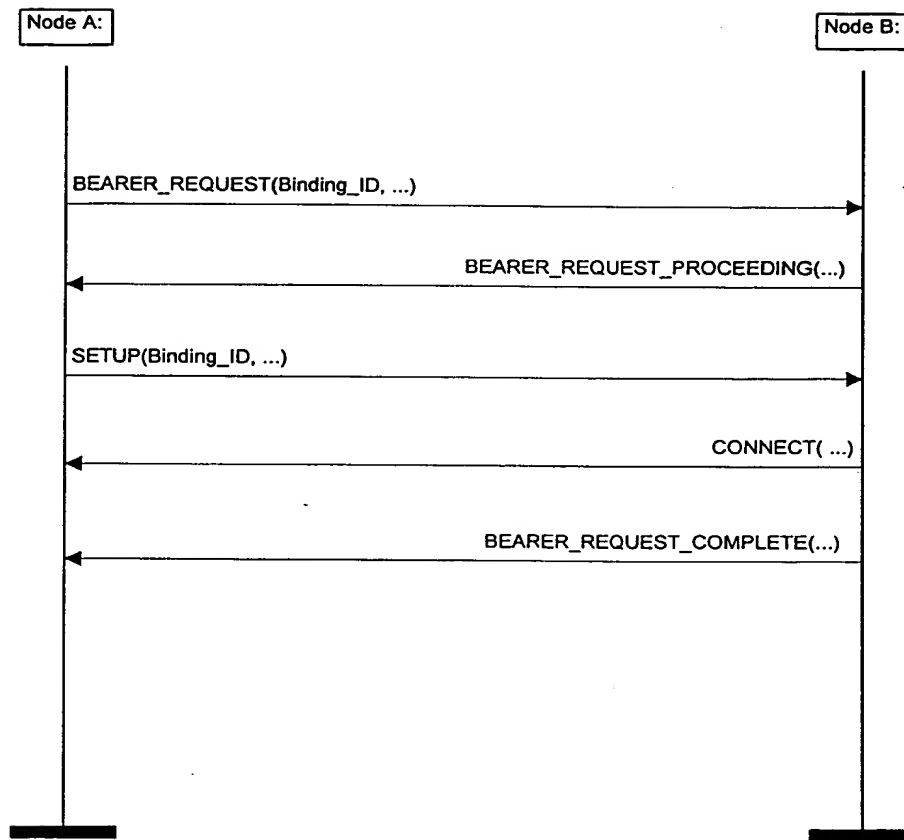


Fig. 5.

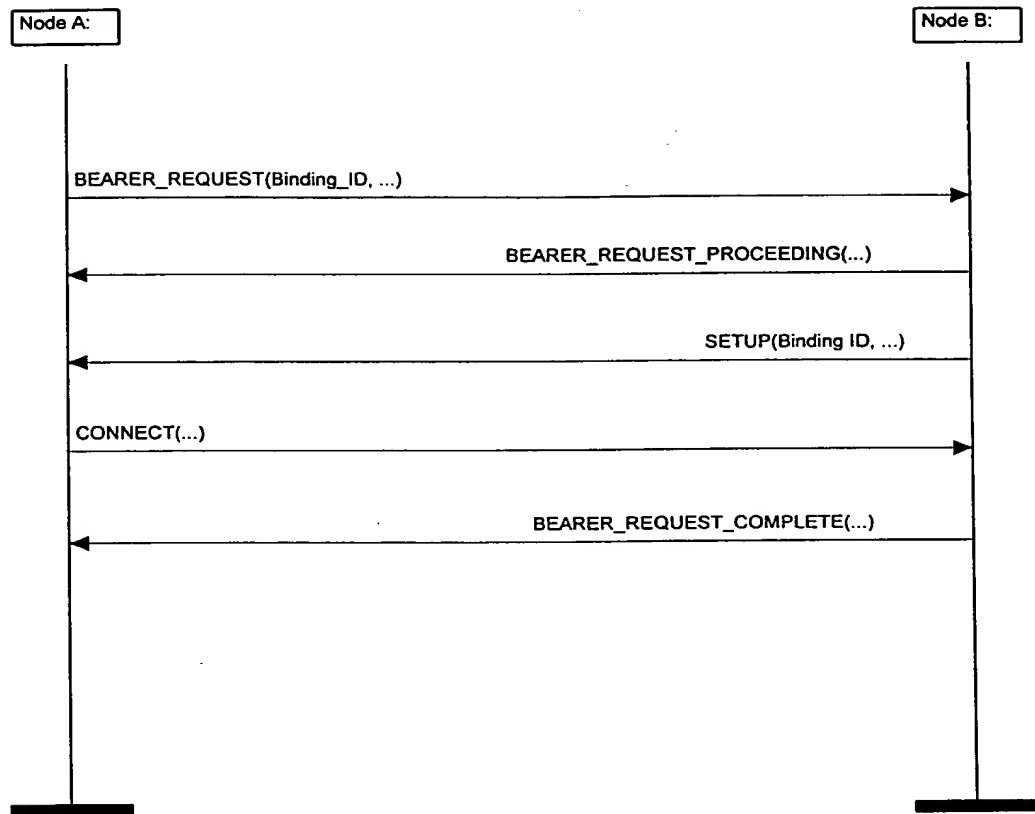


Fig. 6.

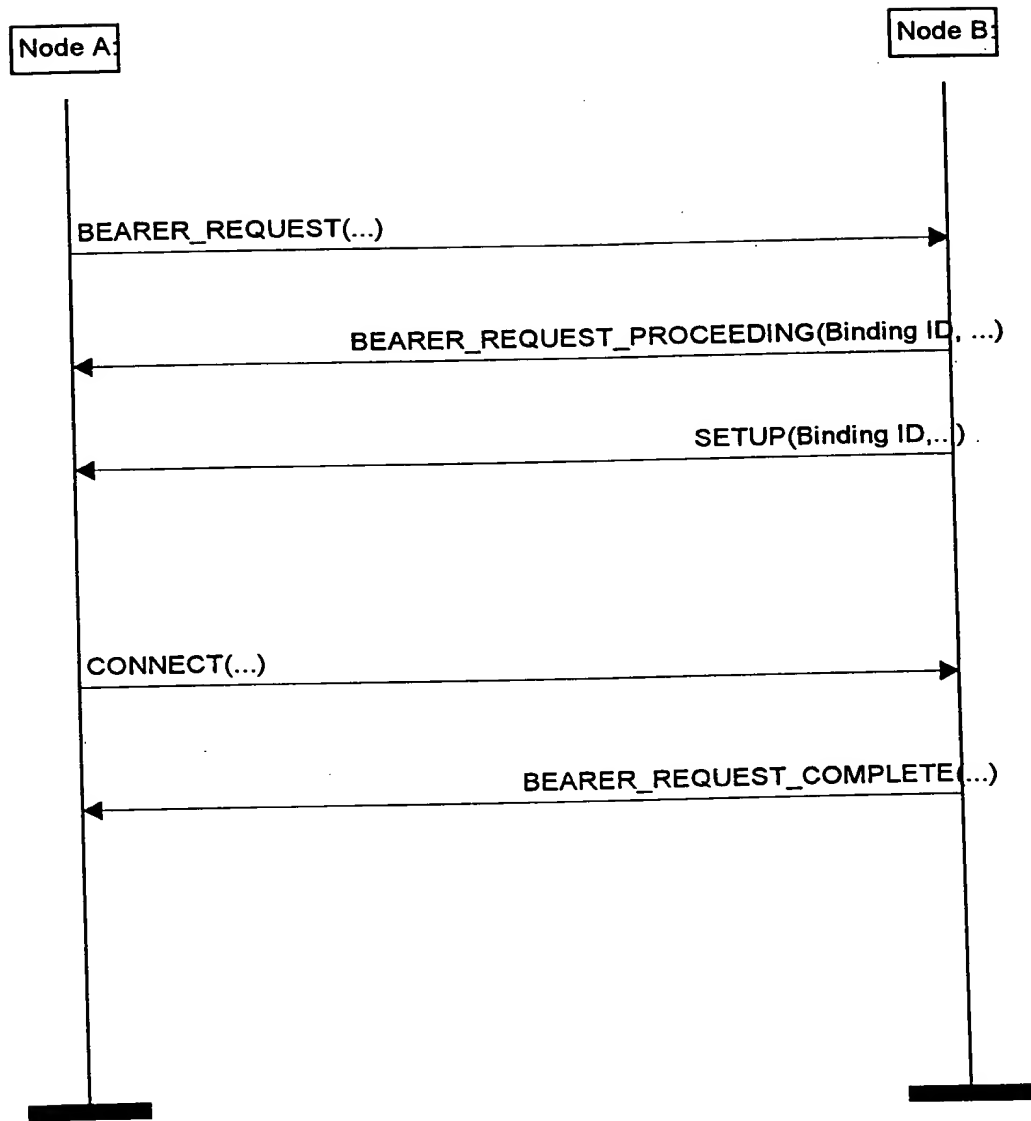


Fig. 7

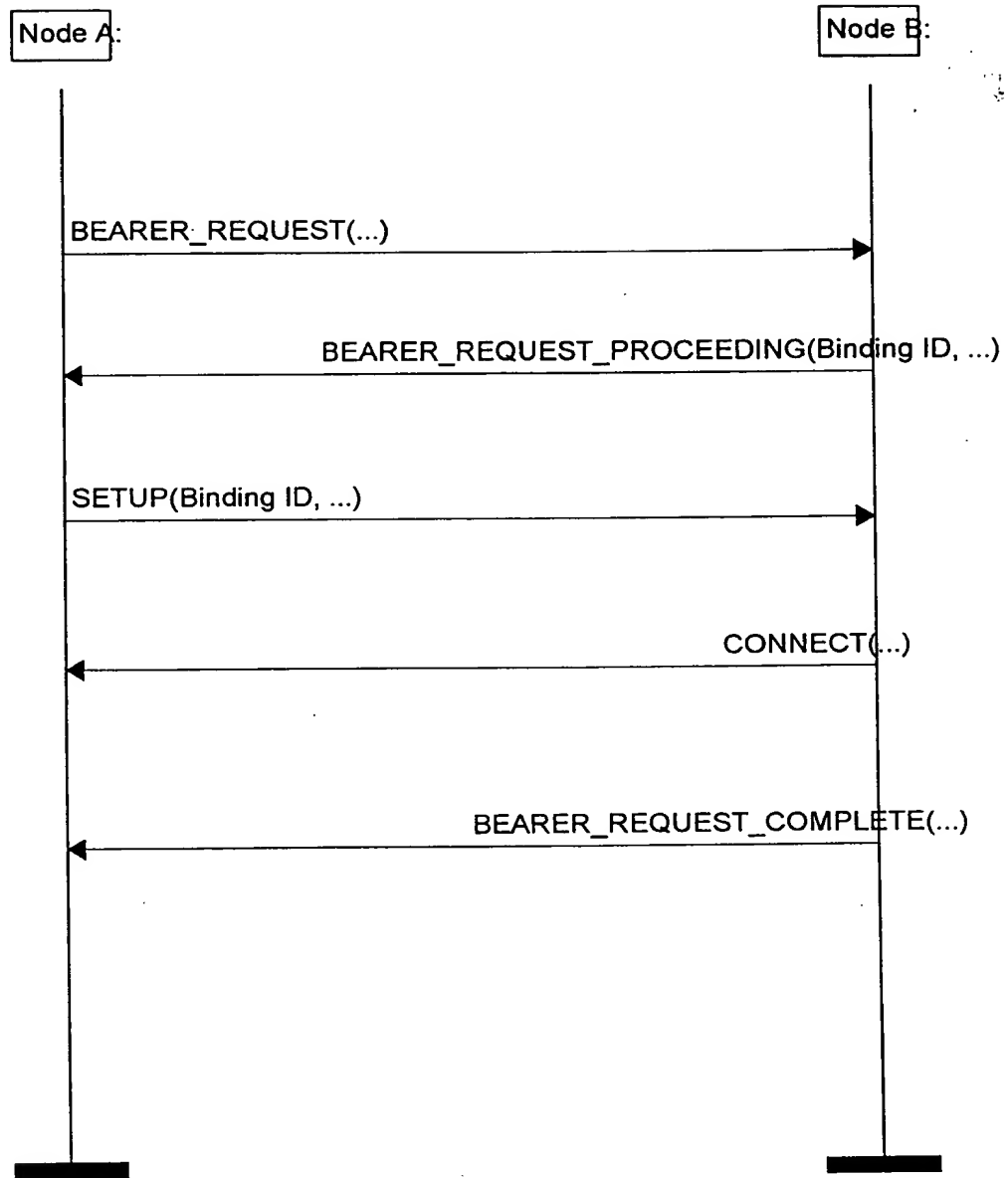


Fig. 8.